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TABLE II.

Latitudes of Belts from Measures.

	Distance from Centre of Disc at Mean Distance 5·20				
	(D) Centre of S. Trop. Belt.	(Fs) S. Edge of S. Eq. Belt.	(Fn) N. Edge of S. Eq. Belt.	(L) Centre of N. Eq. Belt.	(N.) Centre of N. Temp. Belt.
Average of 5 Visual Measures ...	− 9″·52	− 6″·41	−3″·00	+ 2″·70	+ 8″·72
Average of 7 Photographic Measures	− 9·70	− 7·12	−2·70	+ 2·68	+ 8·85
Mean ...	− 9·61	− 6·77	−2·85	+ 2·69	+ 8·78
Apparent latitude	−32°·33	−22°·13	−9°·13	+ 8°·60	+29°·25
Correction to centre at mean date (1905 March 4)	+ 2·74	+ 2·74	+2·74	+ 2·74	+ 2·74
True latitude (φ) ..	−29·59	−19·39	−6·49	+11·34	+31·99

The Annular Nebula in Lyra (*M* 57). By E. E. Barnard.

In *Monthly Notices* of the Royal Astronomical Society for 1900 January I have given a paper on the Annular Nebula of *Lyra* (*M* 57), in which it was shown that measures of the central star of the nebula with reference to a 12^{m} star (*a*) following, made by Professor Burnham in 1891, consistently differed from measures made by the writer in 1898 and 1899 by 1° in angle and 1″ in distance. The distance had apparently diminished, and it was there suggested that this difference might possibly be due to motion in the nebula.

Professor Asaph Hall had measured a number of small stars about the nebula in 1877 with reference to *a*. These stars were remeasured by me in 1899, but they did not indicate any motion in *a*; they seemed to be stationary, with the possible exception of the star *f*. Professor Hall did not see the central star, and hence there are no measures prior to those of Professor Burnham.

In 1900 February Professor Scheiner and I measured at Potsdam a negative made by Dr. Scheiner in 1894 October 29 (see *Monthly Notices*, January 1900, p. 257), which gave results that did not verify the suspected change in the position of the nucleus.

In 1900 September Professor F. P. Leavenworth, of the University of Minnesota, measured these stars and the nucleus on several negatives taken by him in 1897–1900 (see *Monthly Notices*, vol. lxi. p. 25).

In 1902 Mr. Burt L. Newkirk, of Minneapolis, from all the measures, determined the proper motion and the parallax of the

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nebula in an inaugural dissertation for the Doctor's degree at Munich—"Eine Untersuchung der Parallaxe des Zentralsternes des Ringnebels in der Leier" (Munich, 1902).

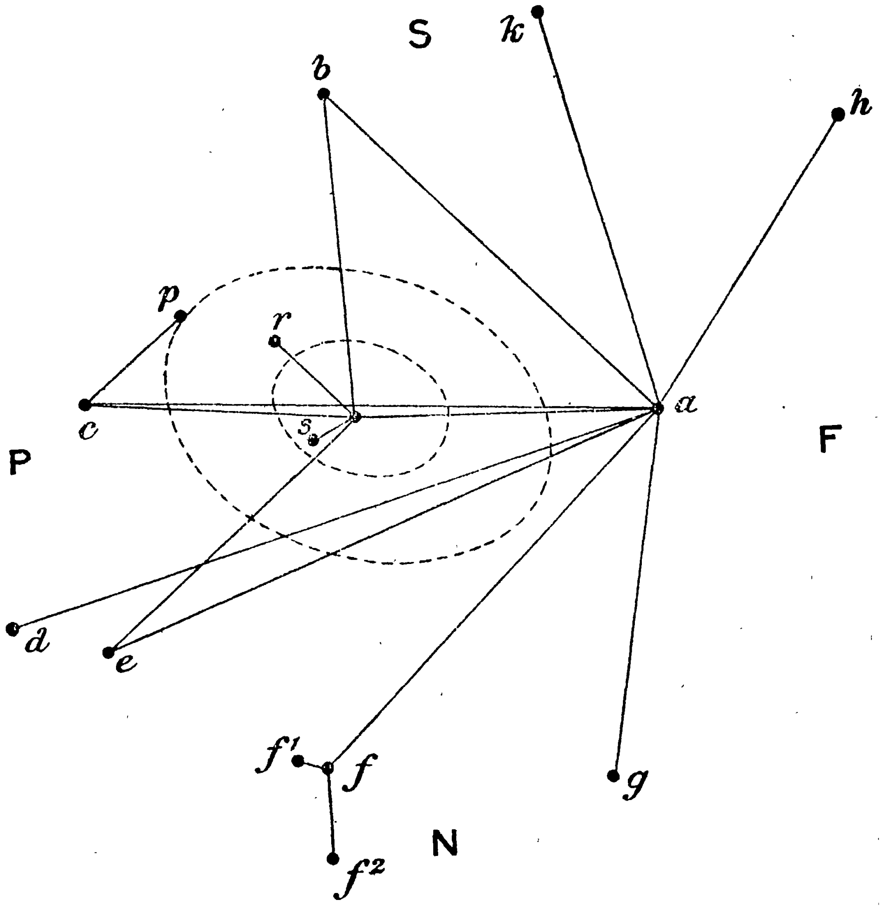
For the proper motion of the central star Dr. Newkirk got the values

$$\Delta\alpha = -0^{s}{\cdot}012 \pm 0^{s}{\cdot}0012$$
$$\Delta\delta = +0''{\cdot}10 \pm 0''{\cdot}029.$$

These would give the following for the direction and amount of the annual motion of the central star:

Direction of motion pos. ang. 303°·7
Amount „ 0''·180.

Dr. Newkirk found for the parallax a value of 0''·10.



As this was the first nebula whose distance and proper motion had ever been determined it became of the greatest importance to verify the results.

To strengthen the value of the measures made by me in 1898–9 I have recently measured two photographs of the nebula

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which I made with the 40-inch telescope and a colour-screen on 1900 September 2 and September 3. These agree quite closely with the visual measures, and give a good foundation for the comparison of any measures made hereafter.

Sufficient time having elapsed to test the above results, in 1903 and 1904 I again measured the position of the nucleus with respect to *a*. According to Dr. Newkirk's value of the motion the total displacement of the nucleus in the five years that had elapsed would be 0″·90; and in the direction of *a* the displacement would be 0″·75, which would be easily measurable. It will be noticed that the direction of motion given by Dr. Newkirk would increase the distance from the star *a*, which cannot be reconciled with the early and late measures of the distance from the nucleus to *a*.

The results from these measures of 1903–4 do not verify the motion derived by Dr. Newkirk. They seem to imply that there has been no measurable change in the position of the nucleus or central star, and they certainly show that the relatively large motion assigned it does not exist. Dr. Newkirk's motion lies nearly in the direction of the star *e*, and to further test his values I have recently made on two nights measures of the position-angle and distance of *e* from the nucleus. This distance should have diminished an entire second of arc, but the measures show no certain change.

As Dr. Newkirk's parallax for the central star depends upon the proper motion which he determined, and which is shown not to exist, the parallax itself must be fallacious.

The discordance in the position of the star *f* as measured by Professor Hall and myself led me to suppose that *f* had a small proper motion, but the measures of the present year show that there is no definite motion even in this star. Indeed, everything in the immediate region of this nebula seems to have the usual fixity of the ordinary small stars.

In the paper for *Monthly Notices* for 1900 January, p. 250, attention was called to a 17^{m} star which was at the limit of the 40-inch visually, and which I could not measure. On 1900 July 29, with good seeing, this star could be seen very steadily. If necessary, its position could have been measured readily. This star should not, therefore, be considered as the limit of the 40-inch visually under good conditions. On this same occasion I could see the second star inside the ring. It was north preceding the nucleus, and was estimated to be $8\frac{1}{2}''$ distant in the direction of the star *d*, or in position-angle 300°±. This agrees closely with the position subsequently measured on the photographs. At this time the central star was bright and easy, and was estimated to be 13 magnitude.

Conditions of steadiness make a very great difference in the visibility of a faint star in a large telescope. The difference is still greater if the star happens to be immersed in nebulosity.

On the two photographs of 1901 September 2 and September 3

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I have measured the position of this second star in the ring, and also another star on the inner edge of the preceding part of the ring. This last star could be measured on only one plate.

Measures of the Photographs.

Nucleus and *a*.

Sept. 2	1901·671	88° 55′	60″·73
3	·673	89 01	60·56
	1901·67	88 58	60·64

Nucleus and *b*.

Sept. 2	1901·671	185° 21′	64″·98
3	·673	185 21	64·87
	1901·67	185 21	64·92

Nucleus and *c*.

Sept. 2	1901·671	268° 22′	54″·83
3	·673	268 17	54·84
	1901·67	268 19	54·83

Nucleus and *e*.

Sept. 2	1901·671	312° 50′	71″·14
3	·673	312 49	71·12
	1901·67	312 49	71·13

a and *b*.

Sept. 2	1901·671	225° 28′	93″·71
3	·673	225 21	93·79
	1901·67	225 25	93·75

a and *c*.

Sept. 2	1901·671	268° 39′	115″·58
3	·673	268 40	115·31
	1901·67	268 39	115·45

a and *d*.

Sept. 2	1901·671	286° 42′	137″·29
3	·673	286 47	137·30
	1901·67	286 45	137·30

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a and *e*.

Sept. 2	1901·671	292° 46′	122″·38
3	·673	292 40	122·33
	1901·67	292 43	122·35

a and *g*.

Sept. 2	1901·671	350° 28′	76″·31
3	·673	350 28	76·21
	1901·67	350 28	76·26

a and *f*.

Sept. 2	1901·671	314° 53′	99″·84
3	·673	314 47	99·88
	1901·67	314 50	99·86

f and *f*1.

Sept. 2	1901·671	261° 11′	4″·98
3	·673	262 12	4·93
	1901·67	261 41	4·95

f and *f*2.

Sept. 2	1901·671	3° 08′	18″·19
3	·673	3 22	18·15
	1901·67	3 15	18·17

a and *h*.

Sept. 2	1901·671	148° 16′	70″·73
3	·673	148 10	70·82
	1901·67	148 13	70·77

a and *k*.

Sept. 3	1901·673	195° 56′	84″·71

c and *p*.

Sept 2	1901·671	133° 48′	27″·41
3	·673	133 41	27·53
	1901·67	133 45	27·47

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Nucleus and *s*.

		° ′	″
Sept. 2	1901·671	300 36	10·23
3	·673	300 44	10·31
	1901·67	300 40	10·27

Nucleus and *r*.

		° ′	″
Sept. 3	1901·673	223 31	21·83

The exposure times for these photographs were

1901	h m		h m	
Sept. 2	19 40	to	23 15	Sid. time
„ 3	8 30	„	11 40	Central standard time.

These plates were measured on a Gaertner Measuring Machine, with which position angles and distances can be determined. When they were originally made no such machine was available.

On the plate of September 3 *Atlas* and *Pleione* and *Electra* and *Celæno* of the *Pleiades* were allowed to trail. A few short exposures on these stars were also impressed on the same plate, which remained undisturbed in the telescope. From these the parallel and scale values were determined in the measuring machine, and were used for the reduction of the measures. The parallel in the plate of September 2 was determined by a comparison of the known angles obtained from the other plate. These measures are therefore entirely independent of the micrometer of the 40-inch.

As the two photographs were made with a yellow colour screen and Cramer Instantaneous Iso plates the magnitudes of the small stars on the plate will not be very different from what they are visually. I have thus compared several of the stars in the nebula with some of those outside, whose magnitudes I had already estimated (*Monthly Notices*, vol. lx. p. 248).

Following are the magnitudes thus derived :—

	m				
p =	14·8	from comparisons with		6	different stars
s =	14·2	„	„	3	„
r =	14·7	„	„	3	„
nucleus =	13·6	„	„	9	„

Hence none of these stars would be difficult if free from the nebula.

The measures made in 1903 and 1904, especially the distances, are not very accordant. Good nights could not be selected for the work, and the nucleus was measured at times when the seeing was so bad that the measures should not have been made. There are enough observations, however, to eliminate the effect of poor

*K 2

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seeing, and I think the mean results are satisfactory. No observation has been rejected. On two dates the nucleus could not be seen after the angles were measured, and the distances could not be obtained.

These observations follow :—

Nucleus and *a*.

(1903).

July 21	1903·552	88°·44	59″·83
27	·569	88·40	...
Aug. 10	·607	89·01	60·50
11	·610	88·94	60·36
17	·626	88·91	60·65
18	·629	88·35	60·89
24	·645	89·02	61·30
31	·664	89·65	60·73
Sept. 1	·667	88·71	60·35
7	·684	88·82	60·67
21	·722	88·79	60·86
22	·725	88·74	60·68
28	·741	88·86	61·22
Oct. 13	·782	88·84	61·30
27	·821	88·52	60·88
	1903·669	88·80	60·73

(1904).

Apr. 26	1904·319	89°·17	61″·39
May 17	·376	89·35	60·73
June 14	·453	89·07	61·08
July 9	·521	88·66	60·67
Aug. 1	584	88·48	...
26	·653	88·69	60·52
	1904·484	88·90	60·88

Following are the measures made in 1905 :—

Nucleus and *e*.

Nov. 26	1905·904	312°·87	71″·38
28	·909	312·85	70·91
	1905·91	312·86	71·14

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a and *f*.

Nov. 26	1905·904	314°·78	100″·08
28	·909	314·75	100·11
	1905·91	314·76	100·09

f and *f*¹.

Nov. 28	1905·909	258°·32	5″·15

In these observations the conditions were very poor, and the nucleus was very difficult. The images of *f* and *f*¹ were very much blurred, and the measures difficult and uncertain.

Following is a collection of all the measures of the nucleus and of the small stars near the nebula that are known to me :—

Nucleus and *a*.

Burnham	1891·45	87°·8	61″·69	(5n)
Scheiner and Barnard	1894·83	88·92	60·71	(1n) photo
Barnard	1898·60	88·77	60·70	(5n)
Barnard	1899·48	89·14	60·66	(5n)
Leavenworth ...	1899·55	89·29	60·56	(4n) photo
Barnard	1901·67	88·96	60·64	(2n) photo
Barnard	1903·67	88·79	60·73	(15–14n)
Barnard	1904·48	88·90	60·88	(6–5n)

Nucleus and *b*.

Barnard	1899·58	185°·37	65″·04	(3n)
Leavenworth ...	1899·84	186·61	65·17	(1n) photo
Barnard	1901·67	185·35	64·92	(2n) photo

Nucleus and *c*.

Barnard	1899·53	267°·59	54″·92	(3n)
Leavenworth ...	1900·13	268·82	55·34	(2n) photo
Barnard	1901·67	268·32	54·84	(2n) photo

Nucleus and *e*.

Barnard	1899·49	312°·38	70″·96	(3n)
Leavenworth ...	1899·55	312·80	71·32	(4n) photo
Barnard	1901·67	312·82	71·13	(2n) photo
Barnard	1905·91	312·86	71·14	(2n)

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a and *b*.

Hall	1877·6	225°·5	93″·90	(2n)
Barnard	1899·51	225·76	93·58	(3n)
Leavenworth	1899·84	225·57	94·38	(1n) photo
Barnard	1901·67	225·41	93·75	(2n) photo

a and *c*.

Hall	1877·6	268°·0	115″·83	(2n)
Barnard	1899·50	268·78	115·58	(3n)
Leavenworth	1900·13	268·63	115·55	(2n) photo
Barnard	1901·67	268·66	115·44	(2n) photo

a and *d*.

Hall	1877·6	286°·9	138″·58	(2n)
Barnard	1899·50	286·96	137·60	(4–3n)
Leavenworth	1900·17	286·76	137·44	(3n) photo
Barnard	1901·67	286·74	137·30	(2n) photo

a and *e*.

Hall	1877·6	292°·6	122″·90	(2n)
Barnard	1899·47	292·81	122·13	(2n)
Leavenworth	1899·55	292·71	122·37	(4n) photo
Barnard	1901·67	292·72	122·35	(2n) photo

a and *g*.

Hall	1877·6	350°·5	77″·18	(2n)
Barnard	1899·51	350·78	76·16	(4n)
Leavenworth	1900·17	350·32	76·46	(3n) photo
Barnard	1901·67	350·47	76·26	(2n) photo

a and *f*.

Hall	1877·6	313°·7	101″·79	(2n)
Barnard	1899·50	315·39	99·97	(2n)
Barnard	1901·67	314·83	99·86	(2n) photo
Barnard	1905·91	314·76	100·08	(2n)

f and f_1.

Hall	1877·6	253°·3	3″·96	(2n)
Barnard	1899·53	262·95	4·89	(3n)
Barnard	1901·67	261·69	4·95	(2n) photo
Barnard	1905·91	258·32	5·15	(1n)

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f and *f*2.

Hall	1877·6	4°·8	17″·31	(2n)
Barnard	1899·52	3·42	17·86	(2n)
Barnard	1901·67	3·25	18·17	(2n) photo

a and *h*.

Barnard	1899·47	148°·14	70″·52	(3n)
Leavenworth ...	1899·55	148·59	70·42	(4n) photo
Barnard	1901·67	148·22	70·77	(2n) photo

a and *k*.

Barnard	1899·59	195°·86	85″·16	(5n)
Barnard	1901·67	195·93	84·71	(1n) photo

c and *p*.

Barnard	1899·52	133°·34	27″·24	(2n)
Barnard	1901·67	133·74	27·47	(2n) photo

Nucleus and *s*.

Barnard	1901·67	300°·66	10″·27	(2n) photo

Nucleus and *r*.

Barnard	1901·67	223°·52	21″·83	(1n) photo

Nucleus and *d*.

Leavenworth ...	1900·17	299°·78	81″·97	(3n) photo

Nucleus and *g*.

Leavenworth ...	1900·17	32°·50	90″·13	(3n) photo

Nucleus and *h*.

Leavenworth ...	1899·55	121°·18	113″·84	(4n) photo

As stated in my previous paper, *Monthly Notices*, vol. lx. p. 252, the final reduction of all the measures of the micrometer screw gave a less value for it than was used in my previous measures. The present observations are reduced with the adopted value of 9″·665. Where my former measures are quoted in the present paper they have been re-reduced with the above value of the screw.

Yerkes Observatory, Williams Bay, Wis.:
1905 *December.*